ISSN 0377-4910

ICMR BULLETIN

Vol.33, No.7 July, 2003

DEVELOPING LARVIVOROUS FISH NETWORK FOR MOSQUITO CONTROL IN URBAN AREAS: A CASE STUDY

In India, malaria had been considered predominantly a problem of rural areas and the activities of the National Anti Malaria Programme (NAMP) were largely rural oriented. While in cities with over 40,000 populations, malaria control activities were expected to be implemented by the local bodies[1]. At present there is an alarming situation due to the rising trend in mosquito-borne diseases in urban areas. The escalation in the incidence of these diseases is closely related to unplanned urbanization, increase in water storage practices resulting in the creation of favourable habitats for vector proliferation, development of commerce and industrialization, and influx of labour from rural to urban areas[2,3]. In urban agglomeration, both man-made and natural habitats provide ideal conditions conducive for the proliferation of mosquito vectors. As a consequence, malaria and dengue have emerged as major health problems in several urban areas. The use of insecticides/ larvicides over the years is responsible for the development of resistance against these chemicals in mosquitoes and has rendered them ineffective in many places. Thus, there is an urgent need to review and strengthen the on-going urban malaria control programme with appropriate technologies so as to reduce the reliance on chemical insecticides and preserve them for emergency situations.

The usefulness of larvivorous fishes especially the Gambusia and Poecilia (guppy) in mosquito control operations in different situations has been proved globally[4-10]. In India, use of larvivorous fishes constitute one of the important components of the Urban Malaria Scheme (UMS) and this has been incorporated in the Malaria Action Plan of the NAMP[11]. It has also been incorporated as an important component of the selective vector control strategy in the Enhanced Malaria Control Project (EMCP) launched in 1998 with World Bank support in the tribal ares of Gujarat and other parts of the country. Presently, the Urban Malaria Scheme is faced with operational constraints[12]. Due to the emerging threat of malaria and dengue in urban areas, Malaria Research Centre (MRC) Field Station at Nadiad in collaboration with the Ahmedabad Municipal Corporation took up a demonstration project on the management of malaria and dengue vectors in Ahmedabad city. Owing to the lack of an adequate set-up and fish resources, attempts were made to develop an operational larvivorous fish network in the city as a model for an urban area. In most of the urban areas, a little attention has been paid towards the development of larvivorous fish resources and its operational mechanism. An attempt has been made in the present write-up to disucss about the development of larvivorous fish network and its operational

mechanism in urban areas based on the experience of Ahmedabad city.

Development of Larvivorous Fish Network

The development of larvivorous fish network in Ahmedabad was carried out in a phased manner as part of a project on demonstration of integrated control of malaria and dengue vectors in the city.

Preparatory phase

The preparatory phase included the following components :–

- Survey of the area to assess mosquito breeding potential, existing larvivorous fish resources and identification of suitable places for developmnet of fish hatcheries.
- Provision of required materials and equipment.
- Provision of manpower and essential training.
- Development of larvivorous fish resources.
- Construction of fish distribution tanks at decentralized level.

Survey of the area

During the preparatory phase (June 1998 - May 1999) a survey of the potential mosquito breeding habitats and aquatic habitats suitable for the development of larvivorous fish hatcheries was carried out in the city. There were large number of domestic and peri-domestic mosquito breeding habitats *viz*., open cemented overhead and ground level tanks, underground tanks, mill tanks, water hydrants, fountains, cisterns (earthen barrels) sluice valve chambers, ornamental tanks in gardens, curing tanks and lift pits at construction sites, wells, ponds/pools, industrial waste water pools, troughs for storing drinking water for cattle, open drains, ditches/small pools and water logged low lying areas ideally suited for the breeding of malaria and dengue vectors and nuisance mosquitoes. These habitats were found suitable for the introduction of larvivorous fishes. Some of the sites were selected for the development of larvivorous fish hatcheries to ensure the availability of larvivorous fishes in the entire city.

Materials and equipment

Development of an operational programme of larvivorous fishes for mosquito control requires provision of certain equipment and materials which included:

(i) One jeep and a trailer with galvanized container and plastic liner.

(ii) Fish collecation nets:
- Fine mesh seine nets of sizes 2x5 m, 2x10 m – One each
- Nylon nets for fish collection or hapas (1x1.5x1.5 m) – Five
- Bamboo nets – Five

(iii) Plastic containers:
- Plastic buckets (200-250 l) for transportation of fish – Six
- Plastic sieves of different sizes – Ten
- Plastic buckets (20 l) for fish application – Ten

(iv) Oxygen cylinder (For long distance transportation) – One

(v) Polythene bags (as required)

Manpower and training of staff

A fish application team comprising 4 field workers and a supervisor (superior field worker) is required to be raised. Skilled and experienced staff in the field of larvivorous fishes is generally lacking in most of the urban areas. The supervisors, inspectors and other field staff of the Ahmedabad Municipal Corporation engaged in anti-larval operations were given necessary training pertaining to the use of larvivorous fishes in msoquito control. They were given field demonstrations of various operational aspects, such as establishment of fish hatcheries, collection and identification of larvivorous fishes, precautions during transport and fish application, *etc.* Attempts were also made to popularise the use of larvivorous fishes among the community and by individuals by organising health education campaigns and public demonstrations in the city.

Development of larvivourous fish resources

Perennial ponds and tanks of different sizes are commonly found in urban, peri-urban and industrial areas. Many of these can be used for mass production of larvivorous fishes. In order to develop the network of larvivorous fishes, the available stocks of the fishes in the Ahmedabad city was reviewed. The mother stocks of gambusia and guppy were available in some mill hydrants and cemented tanks. There were several garden tanks, lakes, mill hydrants, unused swimming pools, a few industrial tanks and tanks in institutional campuses suitable for developing as larvivorous fish hatcheries. A large ancient lake, Kankaria in the old city spreading

about 10 ha and the recreational lakes of Parimal and Law gardens were found suitable for multiplication of larvivorous fishes. The production and maintenance of larvivorous fish stocks in these lakes was found to be very economical and easy and it did not interfere with aesthetic usage of these lakes. Some perennial ponds in the periphery of the city, *viz*. in Vatva, Sardarnagar and Naroda wards were also converted into larvivorous fish hatcheries. Necessary steps such as removal of debris and introduction of hydrilla plant at new sites were taken to ensure better survival of the fishes. Thus, a stock of over ten million larvivorous fishes was raised during 1998-99 and introduced into different breeding habitats as a part of integrated control measures against mosquitoes.

Construction of localized fish stocking/distribution tanks

Decentralised larvivorous fish distribution tanks were constructed by the municipal corporation in some wards/ muster offices for public distribution of larvivorous fishes and facilitating their collection and introduction by the health staff in their respective areas. The size of these tanks ranged from 0.5 – 1.5 m. The average cost of construction came to Rs.2500/- per tank. Different kinds of cemented tanks available in the residential as well as institutional campuses were also used as fish stocking, collection and distribution points for use by the community and field staff engaged in anti-larval activities.

Operational phase

In the operational phase fishes were collected and introduced in different types of mosquito breeding habitats as and when required.

Fish collection, transportation and application

Larvivorous fishes were captured from the hatcheries with the help of seine nets of different sizes or bamboo nets, depending upon the requirement of the fish and type of the hatchery. Fishes were first transferred to plastic buckets with the help of soft plastic sieve to avoid injuries and then to big plastic tubs/drums for transportation.

The fishes were transported in open plastic containers to the application sites and distribution tanks in ward offices. The open containers allow exchange of atmospheric oxygen in water. The containers were filled with water at about two third level and properly covered with fine nylon net and placed in fixed positions in the vehicle. The following precautions need to be taken during the transportation of fishes from hatcheries to the target mosquito breeding habitats –

- Avoid overcrowding to prevent mortality during transportation.
- A maximum of 2000 fishes should be kept in one plastic drum of about 200-250 litres capacity.
- Steady driving for avoiding spillage of water from containers while transportation.
- Avoid sudden stoppage of the vehicle to save the fishes from injuries.
- Young hatchlings should not be transported because they do not sustain the stress during transportation.

Geographical reconnaissance of mosquito breeding habitats was carried out in all the 43 municipal wards of Ahmedabad city. Breeding habitats suitable for fish application were identified. Fish application was carried out at the rate of five to ten fish/m^2 surface area of the water body. More fishes were introduced in fountains, wells, sluice valve chambers, elevator chambers (lift wells) and polluted water bodies where chances of fish mortality was more due to sudden change in the environment. Monthly fish application was carried out in newly created or constructed habitats and those found with mosquito breeding. During monsoon, the requirement of fishes increases manifold due to the creation of a large number of scattered water bodies.

Community involvement

Community awareness and involvement is very important for the successful implementation of larvivorous fish introduction programme in the urban areas. Attempts were made to popularize the use of larvivorous fishes among the community and individuals by organizing health education campaigns and public demonstrations. Large hoardings were displayed at strategic places in the city and the Municipal Corporation also issued newspaper advertisements giving messages for community awareness. This resulted in the better community interaction and cooperation during the fish application in the domestic mosquito breeding places. This motivated individuals to come forward and collect fishes from the municipal ward offices for introduction in domestic tanks and containers.

Monitoring and maintenance phase

During the monitoring phase impact of introduction of larvivorous fishes on mosquito breeding was assessed.

Survival and stock of the fishes was periodically monitored in sentinel sites and whenever required more fishes were added. Hatcheries were regularly checked to ensure the water requirements and for cleaning and removal of debris for proper maintenance of fish stock.

Impact assessment

Impact of larvivorous fish on mosquito breeding was assessed by monitoring the larval density before and after the application. The most common mosquito breeding places such as under-ground cement tanks, ground level tanks, fountains, elevator chambers (lift wells), wells, mill hydrant tanks, cattle troughs and ponds were exclusively monitored. In general a sharp reduction in the larval densities was observed in most of the habitats during the post application period.

The percentage of breeding positive underground tanks was brought down to 15.8 from 94.7 prior to the fish application. Proportion of ground level tanks showing mosuito breeding was reduced from 81.3 to 18.7% after fish application. Mosquito breeding was recorded in 25 and 33% fountains and elevator chambers (lift pits) during the post application period compared to 85.7 and 100% respectively before the fish application (Table).

Conclusions

Larvivorous fishes are an excellent option in controlling the breeding of malaria and dengue vectors in a variety of mosquito breeding habitats. But, this can be achieved only after following a systematic approach towards developing an operational larvivorous fish network and infrastructure in the form of adequate fish resources, and a fully equipped and trained staff under the Urban Malaria Scheme. Experience of the development of larvivorous fish network for mosquito control in Ahmedabad city demonstrated the feasibility of using larvivorous fishes and proved that this can play an important role in mosquito control in urban areas provided a systematic and planned approach is applied. This strategy would be helpful in controlling the re-emergence of certain vector-borne diseases, particularly in urban areas and will reduce the dependence on insecticides.

Table. Impact of larvivorous fishes on mosquito breeding in different habitats.

Months	Underground tanks		Ground level tanks		Fountains		Elevator chambers		Wells		Hydrants		Ponds		Cattle troughs	
	No.	% positive	No.	% positive	No.	% positive	No.	% positive	No.	% positive	No.	% positive	No.	% positive	No.	% positive
Before fish introduction																
June-99	19	94.7	16	81.3	8	85.7	6	100	9	100	2	100	3	100	2	50.0
After fish introduction																
1999																
July	19	15.8	16	6.3	8	12.5	6	16.7	9	22.2	3	33.3	3	33.3	2	0
August	19	10.5	17	11.8	7	14.3	6	33.3	9	22.2	3	0	3	0	2	0
September	19	5.3	17	5.9	8	25.0	5	60.0	9	11.1	3	33.3	3	66.7	2	0
October	19	5.3	17	5.9	8	12.5	4	25	9	11.1	3	66.7	3	33.3	2	0
November	17	11.8	17	11.8	8	12.5	4	25	9	11.1	3	33.3	3	0	2	0
December	21	9.5	17	5.9	8	25.0	5	20	9	11.1	3	0	3	0	2	0
2000																
January	21	0	17	5.9	8	0	5	20	9	11.1	2	0	3	0	2	0
February	21	0	17	5.9	8	12.5	6	33.3	9	22.2	2	0	3	0	1	0
March	23	13.4	16	18.1	8	0	6	0	9	0	2	0	3	0	2	50.0
April	22	13.6	16	0	8	25.0	5	0	9	0	2	0	3	0	2	0
May	23	0	16	0	8	0	5	20.0	8	0	1	0	3	0	2	0
June	23	13.4	16	18.7	8	25.0	5	0	7	0	1	0	3	0	2	0

References

1. Hati, A.K. Urban malaria vector biology. *Indian J Med Res 106:* 149, 1997.
2. Bang, Y.H. Integrated management of urban mosquito vectors of human diseases. *J Commun Dis 17:* 1, 1985.
3. Kudsen, A.B. and Sloof, R. Vector-borne disease problems in rapid urbanization. *Bull World Health Organ 70:* 1, 1992.
4. Ahmed, W., Washino, R.K. and Geike, P.A. Further biological and chemical studies on *Gambusia affinis*. *Proc Cal Mosq Vector Contr Assoc 38:* 95, 1970.
5. Gerberich, J.B. and Laird, M. A bibliography of papers relating to the control of mosquitoes by the use of fish. An annotated bibliography for the years 1901-1966. *FAO Fisheries Tech Paper 75:* 70, 1968.
6. Haq, S., Prasad, H., Prasad, R.N. and Sharma, T. Availability and utility of local fishes of Shahjahanpur for mosquito control. *Indian J Malariol 30:* 1, 1993.
7. Prasad, H., Prasad, R.N. and Haq, S. Control of mosquito breeding by *Gambusia affinis* in rice fields. *Indian J Malariol 30:* 57, 1993.
8. Sharma, V.P. and Ghosh, A. *Larvivorous Fishes of Inland Ecosystems*. Malaria Research Centre, Delhi, 1994.
9. Sitaraman, N.L., Mahadevan, S. and Swamidas, S. Biological control of *An. stephensi* larvae in wells by *Poecilia reticulata* in Greater Hyderabad city. *J Commun Dis 8:* 315, 1976.
10. Sitaraman, N.L., Karim, M.A. and Reddy, G.V. Observations on the use of *Gambusia affinis holbrooki* to control *An. stephensi* breeding in wells. Results of two years study in Greater Hyderabad city. *Indian J Med Res 63:* 1509, 1975
11. *Operational Mannual for Malaria Action Programme,* Directorate of National Malaria Eradication Programme. Delhi. 1995
12. Pattanayak, S., Sharma, V.P., Kalra, N.L., Orlov, V.S. and Sharma, R.S. Malaria paradigms in India and control strategies. *Indian J Malariol 31:* 141, 1994.

This write-up has been contributed by Dr. S. Haq, Research Scientist and R.S. Yadav, Dy. Director and Officer-in-Charge, Malaria Research Centre Field Station, Nadiad and Dr. V.K. Kohli, Assistant Entomologist, Ahmedabad Municipal Corporation, Ahmedabad.

Printed and Published by Shri J.N. Mathur for the Indian Council of Medical Research, New Delhi
at the ICMR Offset Press, New Delhi-110 029
R.N. 21813/71